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Agricultural Memorandum No 770

Sugar Beet Yields, England and Wales 1941-56

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The following interim report was written in April 1959, and has not previously been recorded in the Ag Mem series. The potential transpirations were calculated in the manner of Tech Bull No 4 and are slightly lower than would have been derived by the present method.

The phrase "actual transpiration", in the light of subsequent work would be better named "effective transpiration".

A double regression analysis on improvement factor I (years after 1940) and effective transpiration (ET) gives

$$\text{Yield} = 0.205\ I + 0.66\ ET - 0.93$$

with a multiple correlation of 0.84 and partial correlations 0.77 and 0.67 respectively.

The influence of weather on sugar-beet yields in England and Wales

Data

Yields of sugar-beet in tons/acre for the country as a whole were taken from "Agricultural Statistics", for the period 1941-1956.

Rainfall for 5 selected stations, Ipswich, Mildenhall, Cranwell, York and Ross-on-Wye were taken from the Monthly Weather Report. Potential transpiration for areas around these stations were calculated using the Smith approximation to the Penman method (regression on sunshine) as outlined in "The Calculation of Irrigation Need".

Method

Actual transpiration from April to September for each of the 5 stations each year was estimated by using the rainfall and potential transpiration figures and assuming a maximum soil moisture deficit of:-

1 inch in April
2 inch in May
3 inch in June
3½ inch in July
4 inch in August and September

For example, if the April potential transpiration was 2.0 in. and the rainfall 0.5 in, then the actual transpiration was estimated as 0.5 in.plus 1.0 in. equalling 1.5 in; the actual can never exceed the potential. The country figure for actual transpiration was taken as the mean of the 5 results.

Results

The correlation between the yield per acre and estimated actual transpiration was found to be + 0.53. If, however, it was assumed that there was an improvement in general husbandry amounting to 2% per annum, this correlation became 0.72.

The regression equation between the two variables was

Adjusted yield = 0.6 x Actual Transpiration.

In detail:-

Year	Yield	Adjusted Yield	Estimated Actual Transpiration	Calculated Yield	Error
1941	9.3	9.3	14.2	8.5	- 0.3
1942	9.4	9.2	14.0	8.6	- 0.8
1943	9.2	8.8	13.3	8.3	- 0.9
1944	7.7	7.2	13.9	8.9	+ 1.2
1945	9.4	8.7	14.9	9.7	+ 0.3
1946	10.6	9.5	16.4	10.9	+ 0.3
1947	7.6	6.7	12.6	8.6	+ 1.0
1948	10.6	9.1	15.3	10.7	+ 0.1
1949	9.5	8.0	12.7	9.1	- 0.4
1950	12.3	10.1	15.3	11.2	- 1.1
1951	10.8	8.6	15.3	11.5	+ 0.7
1952	10.5	8.2	13.6	10.5	0
1953	12.8	9.7	15.7	12.4	- 0.4
1954	10.5	7.8	14.6	11.8	+ 1.3
1955	10.8	7.8	13.4	11.2	+ 0.4
1956	12.3	8.6	14.4	12.3	0

Discussion

The approximate method of finding the potential transpiration is subject to errors which are normally within ± 0.5 in, but which can exceed this. The assumption that the rainfall over the sugar beet fields in England and Wales can be represented by only 5 stations is to say the least, optimistic. The tolerated soil moisture deficits are unconfirmed experimentally. Errors in estimated actual transpiration could therefore amount to 1 inch without much difficulty, leading to an error of ± 0.6 tons per acre in the calculated adjusted yield. In practice the average error at this stage was 0.5 tons/acre. Actual transpiration from April to September ignores variations in sowing date and harvest. The effect of disease also has perforce been ignored.

Conclusion

Notwithstanding the inevitable approximations and the presence of other factors, the countrywide sugar beet yield can be calculated to a fair degree of accuracy by the use of the concept of estimated actual transpiration.

Any comments or suggestions on this paper should be referred to the author.

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